Endangered Species UPDATE

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The Longleaf Pine Landscape of the Southeast:
Almost Gone and Almost Forgotten

by Reed F. Noss

Escaping bleak northern winters, perhaps for the rest of their lives, hordes of visitors to the southeast are greeted by a mass of green as they arrive on the coastal plain. Many northern visitors express amazement that so much of this region is still "wilderness." Unfortunately, what the unfamiliar see as verdant wilderness is actually a severely degraded landscape. The dense pine plantations and second-growth hardwoods that appear natural to the untutored eye are artificial assemblages, vastly different in structure and composition from the vast, open piney woods that stretched in presettlement times from Virginia to Texas.

When the first European settlers came to the southeastern coastal plain, they were impressed by the open, park-like character of the "pine barrens" which dominated this region (Bartram 1791, Williams 1837). William Bartram wrote that "this plain is mostly a forest of the great long-leafed pine (*Pinus palustris Linn.*); the earth covered with grass, interspersed with an infinite variety of herbaceous plants...." At this time, longleaf pine communities covered at least 60 or 70 million acres, over 60% of the upland area of the coastal plain (Wahlenberg 1946, Croker 1979, Ware et al., in press). The presettlement distribution of longleaf pine communities is shown in Fig. 1. Today these communities cover less than 10 million acres (Croker 1979), and almost all of this acreage is second-growth and degraded by logging, turpentining, grazing, and disruption of the natural fire regime.

Fire was the natural force that maintained longleaf pine communities. When fire frequencies and spread of fires were reduced by deliberate suppression and by artificial firebreaks, such as roads and developments, the community changed radically. What was once an open pine savanna with a dense carpet of wiregrass (*Aristida stricta*) and wildflowers became a thicket of hardwoods. Today, intensive forestry (even on public lands such as national and state forests) and urban and agricultural development threaten the few remaining semi-natural stands. This article summarizes some unique ecological aspects of the longleaf pine landscape, and suggests a strategy to restore and maintain viable examples of this landscape in perpetuity.

The dense pine plantations and second-growth hardwoods that appear natural to the untutored eye are artificial assemblages, vastly different in structure and composition from the vast, open piney woods that stretched in presettlement times from Virginia to Texas.

Ecology

Longleaf pine communities, as the dominant vegetation of the southeastern coastal plain, formed the matrix in which other plant communities were embedded. The longleaf pine landscape comprised several associations dominated by longleaf pine in the overstory and wiregrass in the ground layer, with strips and patches of other community-types such as hammocks (mesic hardwood forests) and various wetlands. These communities were below longleaf pine on the slope-moisture gradient, and had lower fire frequencies. Hammocks usually occurred on slopes, and on islands, peninsulas, and other areas protected from fire (Harper 1911). In the coastal plain, very subtle changes in elevation (sometimes on the order of a few centimeters) can have profound effects on plant species composition (e.g., Abrahamson et al. 1984). Slopes greater than 15 degrees are very effective firebreaks (Ware et al., in press).

In Florida and small portions of adjoining states, another upland community, "scrub," occurred usually as islands of often dense sand pine (*Pinus clausa*) and short-statured oaks (particularly *Quercus myrtifolia*, *Q. geminata*, and *Q. chapmanii*) in the open sea of longleaf (Myers, in press). The sharp discontinuities between scrub and longleaf communities, once thought to reflect soil differences (Laessle 1958), appear to be largely a result of fire history, in part controlled by the vegetation itself (Myers 1985). Whereas Florida longleaf pine communities burn lightly at 2 to 5 year intervals under natural conditions, scrub burns catastrophically every 10 to 40 years or longer. Soil differences are determined by the vegetation, rather than vice versa (Kalisz and Stone 1984). As uplands, both scrub and longleaf communities are readily developable and do not have the regulatory protection afforded to wetlands in Florida (Hart 1987, Noss 1987a).

Longleaf pine communities can be divided into two general types: sandhills (also called "high pine," including sites with more clayey soils, or "clayhills") and flatwoods. Christensen (in press) divides the sandhill community into three subgroups: pine-turkey oak (*Quercus laevis*) sandridge, fall-line sandhill, and Florida sandhill associations. Pine-turkey oak sandridge forests are found in austere habitats such as

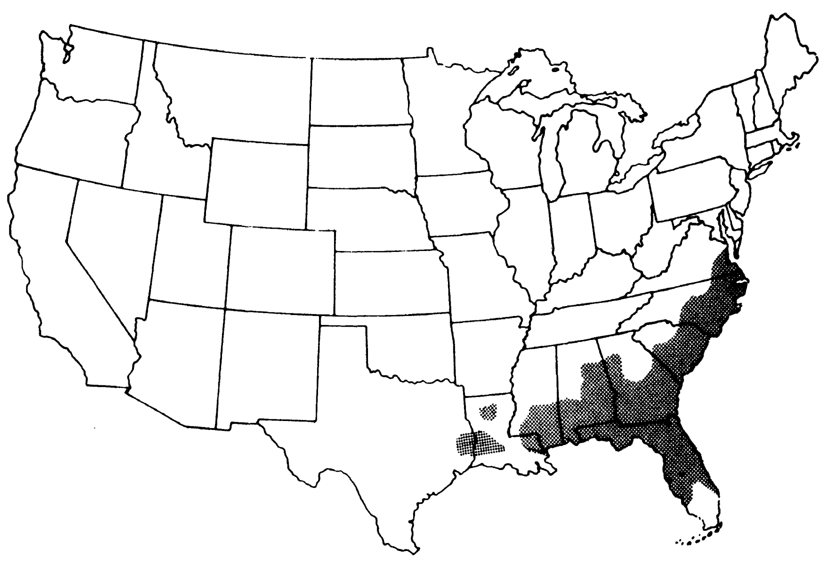

Figure 1: Distribution of Longleaf Pine Communities, adapted from Ware et al., *in press*

ridge tops, sand rims of the California coastal bays, and relict dune ridges on lower coastal terraces. These communities have a characteristic herb layer of lichens. The fall-line sandhills, a mostly continuous band of rolling hills extending from southern North Carolina to Alabama, vary with topography and associated soil differences (Christensen, in press). Florida sandhill associations have three phases, co-dominated by turkey oak on the driest sites, bluejack oak or sand post oak (*Quercus incana* or *Q. margaretta*, respectively) on finer-textured, more fertile soils, and southern red oak (*Quercus falcata*) on calcareous soils, grading into the southern mixed hardwood forest (Monk 1968, Christensen, in press). The clayhill community in the red hill country of southern Georgia and adjacent Florida (Harper 1906, Means, in press) is essentially equivalent to the bluejack oak-sand post oak phase of Florida sandhill.

In contrast to the various sandhill or high pine associations, flatwoods occupy low, flat sites which can be fairly arid but are poorly-drained in wet periods. Flatwoods are the most extensive vegetation type in Florida, occupying some 50% of the state (Davis 1967, Abrahamson and Hartnett, in press). In contrast to sandhills, there is often a well-developed shrub layer. Longleaf pines dominated the mesic flatwoods, the most common flatwoods community, but have been largely replaced by the faster-growing slash pine (*Pinus elliottii*) by foresters. Mesic flatwoods are more open than other flatwoods communities. Saw palmetto (*Serenoa repens*) is the most common shrub, but some well-burned stands have virtually no shrub layer. Lower, wet flatwoods, and those near the coast, are usually dominated by slash pine, with thick patches of saw palmetto, gallberry (*Ilex glabra* or *I. coriacea*), fetterbush (*Lyonia lucida*), wax myrtle (*Myrica cerifera*) and other shrubs. The wettest flatwoods are generally dominated by pond pine (*Pinus serotina*) with loblolly bay (*Gordonia lasianthus*) and a dense shrub layer.

The two characteristic species of virtually all longleaf pine communities are longleaf pine and wiregrass. Wiregrass is a bunch grass that grows extremely dense under natural conditions of frequent fire. Competition with the overlapping roots of wiregrass plants may be one important mechanism of hardwood exclusion in longleaf pine communities (Clewell 1981). Wiregrass, like many herbaceous plants of longleaf communities, normally flowers only after summer fires, and viable seeds are rarely produced; no seedlings have ever been reported in the field.

Endangered Species UPDATE

A forum for information exchange on endangered species issues

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Instructions for Authors:

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Cover:

Red-Cockaded Woodpecker
(Picoides borealis)

Photo by Reed Noss

Wiregrass may be a climatic relict, with present clumps existing vegetatively for perhaps 5,000 years (Clewell 1981). Hence, once the native wiregrass groundcover has been eliminated, such as by site preparation techniques of intensive silviculture or by long-term fire suppression, community restoration is difficult.

The diversity of species in natural longleaf sites is extremely high. Clewell (1981) recorded from 59 to 67 species of herbaceous plants in stands sampled by 30 1-m^2 quadrants. Total-number of species in 8 stands ranged from 66 on xeric sites to 133 in flatwoods adjoining grass-sedge savannas. Animal diversity is also high in these communities. Although a general principle of ecology is that structurally complex habitats contain more species, Engstrom et al. (1984) found more breeding bird species in longleaf pine forests than in more complex beech-magnolia forests. Conversion of natural longleaf stands to pine plantation reduces the species richness, diversity, density, and biomass of birds (Repenning and Labisky 1985).

Longleaf pine is one of the most fire-adapted of all plants. It is the only tree in this region with seedlings (the so-called "grass-stage," a dense tuft of needles at ground-level, arising from a long, thick tap-root) adapted to survive fire (Bruce 1951). Apical growth begins after 3 to 15 years in the grass stage (Croker and Boyer 1975). Because natural longleaf stands are open and savanna-like, fires are frequent but of low intensity, usually burning only the ground layer. Such fires, which in Florida longleaf communities occur naturally at 2 to 5-year intervals but at longer intervals such as 3-10 years in some other areas (Christensen, in press), expose bare mineral soil which longleaf pine seeds require in order to germinate (Chapman 1932). In presettlement times, single fires sometimes burned for weeks and covered areas the size of several counties (Means and Grow 1985). Although Indians may have increased fire frequencies in some areas (Myers and Peroni 1983), the high frequency of lightning strikes in this region is adequate to account for the dominance of pyrophytic vegetation (Komarek 1968, Abrahamson et al. 1984).

The high incidence of fires in longleaf pine communities is related to their high flammability, a consequence of the volatile oils and resins in longleaf pine needles and wiregrass. Mutch (1970) suggested that the flammable properties of some plant species have been favored by natural selection as a means of reducing competition with other species.

Endangered Species

Table 1* lists some endangered, threatened, and otherwise "special" species associated with longleaf pine communities in Florida. The list is not complete, as we are still learning about the distribution of many rare species, particularly plants and invertebrates. A more complete list of longleaf-associated rare species throughout the range of longleaf pine must await further research.

Many of the plants on this list are essentially ecotonal, either restricted to or achieving their greatest abundance in the ecotones between longleaf pine and other community-types (D. Hardin, pers. comm.). The herb bog (also called pitcher plant bog, seepage slope, or savanna) community is an ecotone between flatwoods and shrub bogs or other wetlands (Clewell 1981). Fires sweeping down from the flatwoods prune back encroaching shrubs and maintain the open herb bog community, which can sometimes be hundreds of meters wide (Means, in press). This unique community was characteristic of the Gulf coastal plain of panhandle Florida, Alabama, and Mississippi, but approximately 97% of its former area has been destroyed (Folkerts 1982).

The red-cockaded woodpecker (*Picoides borealis*), lately the focus of much controversy concerning national forest management in the south, is dependent upon old-growth longleaf pine forests. These woodpeckers excavate nesting and roosting cavities in old, living pines infected with red-heart disease. The "resin wells" they peck around the cavity entrance produce a shiny slick of sap which repels predators such as rat snakes. The average age of cavity trees is 95+ years today (Jackson et al. 1979), and 103+ years in the largest remaining population of this species in the Apalachicola National Forest, Florida (Hovis and Labisky 1985). Because longleaf pines can live to 400 years, the average, and probably optimal, age of cavity trees was certainly much older in the past. Modern forestry operations, using short rotations, do not allow the pines to reach an age and size preferred by red-cockaded woodpeckers. An odd and tragic coincidence is that this woodpecker, like its fellow community member, wiregrass, never has been documented to successfully colonize a new site or a former site from which it has been eliminated.

Another rare species that is declining rapidly in the coastal plain is the fox squirrel (*Sciurus niger*), again because old-growth longleaf pine-turkey oak forest is the preferred habitat (Wood 1985). Sherman's fox squirrel (*S. n. shermani*), a subspecies endemic to north-central Florida, is particularly threatened (Ehrhart 1979). An endemic scarab beetle, *(Ataenius sciurus)* appears to be restricted to fox squirrel nests (Franz 1982). Habitat destruction and fire suppression have eliminated fox squirrel populations in many areas, and small populations isolated on remaining sandhill fragments may suffer from genetic and demographic problems. Although Sherman's fox squirrel has been a candidate for listing by the U.S. Fish and Wildlife Service for several years, no action has been taken, and the state of Florida still has an open season on fox squirrels with a bag limit of 2 per day. Based on new evidence indicating severe decline, I have recently (Nov. 21, 1987) filed a formal petition with Interior Secretary Hodel to list this species as Federally Threatened.

Finally, the gopher tortoise (*Gopherus polyphemus*) is one of the most characteristic animals of the sandhills, and probably the most important grazing herbivore of these communities (Means, in press). This fully terrestrial turtle is a keystone species, with over 80 species of commensal invertebrates and vertebrates using its bur-

*(* Table 1 may be found on Update p.6)*

rows, which may be 30 feet long and 15 feet deep (Eisenberg 1983, Cox et al 1987). Many of these species are strictly obligate commensals (e.g., scarab beetles of the genera *Aephodius*, *Copris*, and *Onthophagus*), whereas others, such as the Federally Threatened eastern indigo snake *(Drymarchon corais couperi)*, find optimal habitat there. The gopher tortoise is threatened by habitat destruction, fire suppression (which reduces herbaceous food plants), and hunting and poaching for its meat. The state of Florida permitted hunting of gopher tortoises through 1987, although public pressure finally eliminated the open season in 1988. The U.S.F.W.S. listed western populations of gopher tortoises (extending from the Tombigbee and Mobile Rivers in Alabama to southeastern Louisiana) as Threatened in the July 7, 1987 Federal Register.

Can We Bring Back the Longleaf Pine Landscape?

A rational answer to this question would probably be "no." But effective conservation never has been guided by pure rationality, as the writings of John Muir, Aldo Leopold, and other great conservationists vividly attest. The few remaining near-natural stands of longleaf pine are majestic enough to inspire determined action in any sensitive person who has walked through their dense wiregrass carpets and heard the wind singing through the 8 to 18"-long needles of the pines.

Biologists are beginning to realize the limitations of the species approach to biological conservation (e.g., Noss and Harris 1986, Hutto et al. 1987). Although Table 1 shows that many threatened and endangered species are associated with longleaf pine communities, other major vegetation types in Florida (e.g., sand pine scrub, tropical hardwood hammock) also have large lists. The large lists relate to a high level of endemicity — about 385 species of plants are endemic to Florida, more than any state besides California and Hawaii (Gentry 1986). A focus on rare species, with their narrow and patchy distributions, is not working to protect intact examples of longleaf communities. Furthermore, the typical species-level approach of specifying minimum viable populations, minimum required foraging areas (as for the red-cockaded woodpecker), and other sub-optimal requirements does little to foster true recovery even at the species level. The extreme manipulations of habitat often recommended in species recovery plans evoke images of outdoor zoos, not of wild, natural ecosystems.

Recognizing the longleaf pine system as an endangered community (Means and Grow 1985) might do more to protect higher-order patterns and processes. But by standard classifications, longleaf pine is part of many different associations, each with a unique pattern of species composition and abundance. Moreover, community-level evaluation procedures, such as those applied by heritage programs of The Nature Conservancy, may not assign longleaf pine communities high value. For example, the Florida Natural Areas Inventory (FNAI 1987) ranks sandhill as "G4/S3," meaning that it is apparently secure globally but somewhat vulnerable at a state scale, and ranks mesic flatwoods as "G5/S5" or demonstrably secure at both global and state scales. The problem here is that ranking criteria do not adequately account for the quality of remaining examples. Also, although longleaf pine communities are still not as rare as many community-types, the fact that this once-dominant vegetation of the coastal plain has been reduced by some 85% (or by much more, perhaps 99.9%, if we consider old-growth examples) should be cause for concern. Perhaps "extent of anthropogenic decline" is a more ecologically appropriate criterion than rarity.

A potential solution to the problem of restoring and preserving longleaf pine systems would be to recognize them as endangered landscape-types (see Noss 1987b). This designation would acknowledge the mosaic of interacting communities that occur in natural landscapes, the ecologically critical gradients and ecotones which are often ignored in traditional vegetation analysis, and the regional variation in species composition among sites (gamma diversity). The goal shifts from preserving separate species and communities as "living museums" to preserving entire regional landscapes of intact, interacting ecosystems. Instead of species diversity *per se*, we are interested in native diversity at all scales (Noss and Harris 1986).

A focus on rare species, with their narrow and patchy distributions, is not working to protect intact examples of longleaf communities.

Opportunities to restore and maintain viable examples of longleaf pine landscape-types exist on our large public lands, especially the national forests. Some 62% of known red-cockaded woodpecker colonies (an indicator of old-growth longleaf pine) occur on national forests (Jackson 1978). Unfortunately, these national forests are not being managed in a way that will allow recovery of this species, or of natural landscape-types with the characteristic spatial pattern of communities. To many biologists who have reviewed them, the present round of 50-year forest plans are an ecological disaster (Jackson 1986, Means 1987, Noss 1987c).

If we are to bring back the longleaf pine landscape, large public land areas must be dedicated to this purpose. These "wilderness recovery areas" must be distributed throughout the natural range of longleaf pine and associated communities, in order to represent the full spectrum of native species

(Continued on Update p. 5)

composition, abundance patterns, and inter-population genetic variation. Broad habitat corridors between sites are needed to allow for movement of animals and dispersal of propagules. Considerable ecological research will be necessary to determine optimal methods for restoring and managing the constituent populations, communities, and the landscape as a whole. One immediate priority for longleaf sites is to reestablish the natural regime of summer fires. Above all, we will need a new attitude of respect and humility in order to repair the damage we have done. A land ethic (Leopold 1949) is long overdue.

Reed Noss is a wildlife ecologist, consultant, freelance writer, and lecturer living in Gainesville, Florida. He has authored many technical papers on conservation biology and landscape ecology topics.

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Table 1:

Species associated with Florida longleaf pine communities and listed by the U.S. Fish & Wildlife Service, the state of Florida, and/or the Florida Natural Areas Inventory (FNAI). Longleaf pine communities are not necessarily the primary habitat of every species listed and many species are ecotonal. Data are from Kale (1979), Layne (1979), McDiarmid (1979), Ward (1979), Franz (1982), Wunderlin (1982), Clewell (1985), FNAI (1987), and Deborah White, FNAI (pers. comm.).

Status Codes:

FWS: E=listed Endangered; T = listed Threatened; C1 = candidate for listing, with substantial evidence in support; C2 = candidate for listing, but with substantial evidence of vulnerability and/or threat lacking; 3B = no longer considered for listing because taxon does not meet ESA definition of "species;" 3C = proven to be more widespread or abundant than previously believed.

STATE: E = listed Endangered; T = listed Threatened; SSC = listed Species of Special Concern.

FNAI: G1 (or S1) critically imperilled globally (or in state); G2 (or S2) imperilled globally (or in state); G3 (or S3) = very rare or local throughout range (or in state); G4 (or S4) = apparently secure globally (or locally) but may be rare in parts of range; G5 (or S5) = demonstrably secure globally (or locally); GH (or SH) = of historical occurence; G#? (or S#?) = tentative rank; G#G# (or S#S#) = range of rank; G#T# = rank of taxonomic subgroup; G#Q# = rank of questionable species; U = no rank assigned due to lack of information.

Species	Common Name	FWS Status	State Status	FNAI Status
Plants				
Agalinis purpurea var.carteri	Carter's Large Purple Foxglove	C2		G5TUQ/SU
Agalinis stenophylla	Narrow-leaved False Foxglove	C2		GHQ/SH
Ascepias viridula	Southern Milkweed	C2	T	G2/S2
Aster plumosus	Plumose Aster	3B		G2Q/S
Aster spinulosus	Pine-woods Aster	C2	T	G1/S1
Baptisia hirsuta	Hairy Wild-Indigo	C2	E	G2Q/S2
Baptisia simplicifolia	Scare-Weed	C2	T	G2G3/S2S3
Calamintha ashei	Ashe's Savory	C1	T	G3/S3
Calamintha dentata.	Toothed Savory	C2		G2G3/S2S3
Callirhoe papaver	Woods Poppy-Mallow	T		G3G5/S2
Clitoria fragrans.	Pigeon-Wing	C1	T	G3/S3
Conradina glabra	Apalachicola Rosemary	C2	T	G1/S1
Conradina grandiflora	Large-Flowered Rosemary	C2		G2/S2
Dicerandra frutescens	Scrub Mint	E	E	G1/S1
Eriogonum floridanum.	Scrub Buckwheat	C2	T	G3Q/S3
Euphorbia telephioides	Telephus Spurge	C2		G1/S1
Gentiana pennelliana.	Wiregrass Gentian.	3C	E.	G2?/S2
Gymnopogon floridanus	Florida Beardgrass	C2		G2?/S2
Hartwrightia floridana	Hartwrightia	C2	T	G2G3/S2S3
Hedeoma graveolens.	Mock Pennyroyal	C1	E	G2/S2
Lechea divaricata	Pine Pinweed.	C2		G2/S2
Liatris provincialis	Godfrey's Blazing-Star	C2	E	G2/S2
Lilium catesbaei	Southern Red Lily		T	G4G5/S2

Species	Common Name	FWS Status	State Status	FNAI Status
Linum sulcatum var. harperi	Harper's Grooved-Yellow Flax	C2		G5?TU/S1?
Macbridea alba	White-Birds-in-a-Nest	C2	E	G1/S1
Nemastylis floridana	Fall-Flowering Ixia	C2	E	G2/S2
Nolina brittoniana	Britton's Bear-Grass	C2		G1/S1
Pityopsis flexuosa	Bent Golden-Aster.	C2	E	G3/S3
Platanthera integra	Yellow Fringeless Orchid.	3C	T	G3G4/S3S4
Pteroglossaspis ecristata	Wild Coco.	C2	T	G3G4/S2
Rhynchosia cinerea	Brown-Haired Snoutbean	C2		G3/S3
Rudbeckia nitida	St. John's - Susan	C2	E	G3/S1.
Sarracenia leucophylla	White-Top Pitcherplant		E	G3G5/S3
Scutellaria floridana	Florida Skullcap	C2		G1/S1
Sphenostigma coelestinum	Bartram's Ixia	C2	T	G1G2/S1S2
Spigelia gentianoides	Gentian Pinkroot	C2	E	G1/S1
Tephrosia mohrii	Pineland Hoary-Pea	C2		G1G3/S1
Verbesina chapmanii	Chapman's Crownbeard	C2	T	G2/S2
Warea amplexifolia	Clasping Warea	E	E	G1/S1
Warea carteri	Carter's Warea	E	E	G1/S1

Arachnids

Species	Common Name	FWS Status	State Status	FNAI Status
Geolycosa xera	McCrone's Burrowing Wolf Spider			U/U
Lycosa ericeticola	Rosemary Wolf Spider	C2		U/U

Insects

Species	Common Name	FWS Status	State Status	FNAI Status
Aphodius aegrotus	Scarab Beetle			U/U
Aphodius haldemani	Scarab Beetle			U/U
Aphodius laevigatus	Scarab Beetle			U/U
Aphodius troglodytes	Aphodius Tortoise Commensal Scarab Beetle	C2		U/U
Ataenius sciurus	Scarab Beetle.			U/U
Copris gopheri	Copris Tortoise Commensal Scarab Beetle	C2		U/U
Eucanthus alutaceus	Scarab Beetle.			U/U
Gronocarus multispinosus	Scarab Beetle	C2		U/U
Hypotrichia spissipes	Scarab Beetle			U/U
Mycotrupes cartwrighti	Scarab Beetle			U/U
Mycotrupes gaigei	Scarab Beetle.			U/U
Onthophagus polyphemi polyphemi	Onthophagus Tortoise. Commensal Scarab Beetle	C2.		U/U
Onthophagus p. sparsisetous	Onthophagus Tortoise Commensal Scarab Beetle	C2.		U/U
Peltotrupes profundus	Scarab Beetle			U/U
Phyllophaga elongata	Scarab Beetle			U/U

Amphibians

Species	Common Name	FWS Status	State Status	FNAI Status
Ambystoma cingulatum	Flatwoods Salamander	C2		G4?/U

Species	Common Name	FWS Status	State Status	FNAI Status
Notophthalmus perstriatus.	Striped Newt			G3/S3
Rana areolata	Gopher Frog	C2	SS	G5/S3
Reptiles				
Crotalus horridus.	Canebrake Rattlesnake.			G5/S3
Drymarchon corais couperi.	Eastern Indigo Snake	T	T	G4T3/S3
Eumeces egregius lividus	Blue-Tailed Mole Skink.	T	T	G4?T2/S2
Gopherus polyphemus.	Gopher Tortoise.	C2	SSC	G2/S2
Lampropeltis calligaster.	Mole Snake.			G5/S2S3
Lampropeltis getulus goini.	Apalachicola Common Kingsnake			G5T2/S2
Neoseps reynoldsi	Sand Skink.	T	T.	G2/S2
Pituophis melanoleucas mugitus.	Florida Pine Snake	C2	SSC	G5T3?/U
Sceloporus woodi	Florida Scrub Lizard	C2		G3/S3
Stilosoma extenuatum	Short-Tailed Snake	C2	T	G3/S3
Birds				
Falco sparverius paulus	Southeastern American Kestrel	C2	T	G5T3T4/S3?
Haliaeetus leucocephalus	Bald Eagle	E	T	G3/S2S3
Picoides borealis	Red-Cockaded Woodpecker	E	T	G2/S2
Picoides villosus	Hairy Woodpecker			G5/S3?
Mammals				
Felis concolor coryi	Florida Panther	E	E	G4T1/S1
Mustela frenata olivacea	Southeastern Weasel.			G5T4/S3?
Mustela frenata peninsulae	Florida Weasel	C2.		G5T3/S3?
Podomys floridanus	Florida Mouse	C2	SSC	G3/S3
Sciurus niger shermani	Sherman's Fox Squirrel.	C2	SSC	G5T2/S2
Ursus americanus floridanus	Florida Black Bear	C2.		G5T3/S3

Book Review

The Last Extinction   edited by Les Kaufman and Kenneth Mallory

The last Extinction grew out of a public lecture series entitled "Extinction: Saving the Sinking Ark," held in Boston, Massachusetts, at the New England Aquarium during the fall of 1984. The theme around which the six essays in the book have been organized is that it is both possible and critical to slow the mass extinction episode that is now in progress. In the preface, the editors note that although many people know that we are rapidly losing the diversity of life on Earth, they are not doing anything about it, either because the idea is only an abstraction or because they think the problem is too vast for individuals to have any effect. Hence the overall goal of the book is to "bring extinction down to earth" and to provide readers with a better understanding of what extinction is, what it is not, and how it might be abated. To bring the extinction issue home, several case studies are reviewed from the temperate zones as well as the tropics.

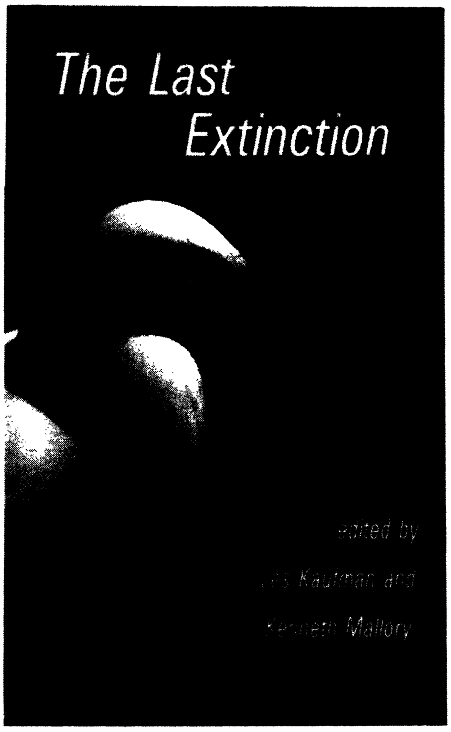
In general, the book is geared more toward a lay audience than technical experts. Nevertheless, its clear explanations of the issues and challenges before us, as well as its valuable presentation of information ranging from a catalogue of species that have gone extinct in North America since humans first arrived on the continent to a discussion of mass extinctions revealed in the fossil record will be of interest to professionals and students familiar the literature on the topic.

The book is divided into three general sections. The first two chapters, written by Les Kaufman and David Jablonski respectively, set the context for the book. In the first chapter, Kaufman examines philosophical, scientific, and practical stumbling blocks to biological diversity conservation. Jablonski, a paleontologist, reviews mass extinctions throughout geological time as a means of drawing a lessons for the current plight of many of the earth's species. Of these lessons, perhaps the most important is that "when the rate of extinction strongly outpaces the evolution of new species, as it is doing with a vengeance today, the stage is set for extreme changes . . . Destruction and extinction may be rapid, but recovery is painfully slow."

The next two chapters are case studies. Ghillean Prance, a tropical botanists, outlines the biology and ecology of the amazon rain forest and discusses the nature and causes of the massive human-caused devastation that is now being imposed upon the land. Jim Williams and Ronald Nowak of the United States Office of Endangered Species , complement Prance's chapter with an assessment of species extinction and protection in North America. Both chapters underscore the need to preserve critical habitats as a primary means to protecting the species that depend on them.

Finally, the last chapters wrestle with future options and conservation needs. Thomas Foose, Conservation Coordinator for the American Association of Zoological Parks and Aquariums (AAZPA) explores the limits and opportunities for captive propagation and reintroduction of endangered species. David Ehrenfeld, a biologist and conservationist, takes a long view of the kind of world we might be living in if we do, or do not make our best efforts at preserving biological diversity. He begins by noting that the "future is shy. If you want to catch a glimpse of it, you have to sneak up on it from behind. So the place to start for a look into the future is the past."

Ehrenfeld then appropriately concludes the *Last Extinction* by describing the situation which we now face in simple and honest terms: "Before we can begin the days of stewardship, we must first end and leave behind the age of exploitation. We can only pray that the passage comes soon and that it is a peaceful one. . ."



The editors also provide a sampling of professional and membership organizations involved in issues relating to species and habitat survival or related issues. The information for this section is drawn in large part from the Conservation Directory 1986 and from the report "Grass Roots Conservation of Biological Diversity in the United States," prepared for the Office of Technology Assessment. The latter report is available through the U.S. Government Printing Office.

The paperback version of The Last Extinction cost $7.95. It is published by:

The MIT Press
Mass. Institute of Technology
Cambridge, Mass 02142

Local Extinction, Metapopulations and Endangered Species

by Susan Harrison

Although the word "extinction" has a negative connotation for most conservationists, population ecologists consider local extinction to be a normal and even frequent process in the population dynamics of certain species. No local population of a species is immortal, and in some organisms, populations tend to be rather short-lived. Habitat succession, occasional catastrophes, plagues of biotic enemies (diseases, predators, competitors), and periodic imbalances in resource bases are among the factors that predispose some species to localized population crashes.

Frequent local extinction is more common among small, short-lived organisms such as annual plants, rodents, and invertebrates than among long-lived organisms such as trees and large mammals. Extinction is also prevalent among species with specialized and patchy habitat associations (certain soil or vegetation types, treefalls, ponds), which cause local populations to be isolated from frequent immigration.

The existence of "natural" extinction bears implications for species conservation strategies. A species can only persist regionally as long as new populations are founded at a rate which balances local extinctions. "Metapopulation" refers to a system of conspecific populations which exchange immigrants with one another, and metapopulation dynamics are the changes in distribution and abundance of a species resulting from extinction and colonization. Metapopulation dynamics are most significant in species that are vulnerable to local extinction and are not exceptionally good disbursers. In such species, populations may appear and disappear in what has been called the "blinking light" or 'shifting mosaic" pattern. The symptoms of this mode of persistence are a distribution that is spatially and temporally variable, and a tendency for the species to be absent from many apparently suitable habitats.

An illustrative example is the Karner blue butterfly (*Lycaena melissa samuelis*), a New York State endangered species. The Karner blue inhabits the pine barrens, a post-fire successional community. Its larvae feed on *Lupinus perennis*, a fire-dependent shrub. While periodic fire is necessary to maintain its habitat and its host plant, the Karner blue cannot withstand fire in any of its life stages. When a large area of pine barrens existed in a fire-successional mosaic, the Karner blue (despite being a rather weak flier) survived by colonizing recently burned areas from populations on adjacent unburned habitat. Habitat reduction and fire suppression have combined to make colonization increasingly difficult, and have led to the butterfly's decline.

Other examples from the conservation literature illustrate the great variety of metapopulational patterns that exist, as well as how these patterns relate to conservation problems. The bay checkerspot butterfly (*Euphydryas editha bayensis*), a federally listed threatened species, is confined to patches of grassland on serpentine soil. Because of the configuration of its habitat, this butterfly forms a metapopulation consisting of a very large "source" population surrounded by numerous small and transient "satellite" populations. The source population is the key to the region-wide survival of the species. The Concho water snake, also federally listed, inhabits riffles and rapids along the Concho and Colorado River. Local populations of this snake form a linear "shifting mosaic," soon to be disrupted by a proposed dam along the lengths of the two rivers. Other species endemic to desert riverine environments, including certain pupfishes (*Cyprinodon* spp.), epitomize metapopulational species now reduced to a single population or a few isolated ones by drastic human modification of their habitat. These species are endangered not only by habitat destruction, but also by the obstruction of the essential flow of migrants between the remaining habitats by dams and water withdrawals.

How can species with natural extinction and recolonization dynamics be protected? A few very general principles can be advanced which provide a sharp contrast to the current single-population emphasis of conservation biology. First, one population is not enough; indeed, the more populations and habitats that can be conserved, the longer a metapopulation may be expected to persist. Second, empty habitats may be as important to a species' persistence as the ones that it occupies since the species' distribution at any moment is partially a matter of chance. Third, unobstructed dispersal between habitat patches is critical to the survival of metapopulations. If natural recolonization cannot keep pace with human-accelerated extinction, artificial introductions may be a valuable alternative. The development of viability analysis methods that take all these factors into account remains a major challenge for conservation biologists.

The Technical Notes page is designed as a forum for thoughts and information on research issues related to endangered species protection. Contributions are welcome. Material should be sent to:

Kathy Freas
Center for Conservation Biology
Stanford University
Stanford, CA 94305

Bulletin Board

New Newsletter on Monarchs & Insect Conservation Issues

A new newsletter produced in California, will serve to disseminate information about the Monarchs and their California wintering colonies, as well as provide information on the latest issues in insect conservation. The first issue, which was published in February 1988, featured articles on migration, protection, and management of California wintering colonies as well as a listing of recent literature on the Monarch. Future issues will include information on the biology and ecology of the Monarchs, brief biographies of people studying and working on the conservation of butterflies, and summaries of a tagging study. To receive the *Danaus*, send a self-addressed stamped (56 cents) envelope to Walt Sakai, Life Sciences, Santa Monica College, 1900 Pico Blvd., Santa Monica, CA 90405.

Video on Tropical Rain Forests

The National Wildlife Federation has produced an 18-minute video about tropical forests. The video first focuses on the numerous pressures causing rapid tropical deforestation, and then examines some of the solutions that are being developed in the United States and around the world to address these critical problems. The video and accompanying printed literature are available through the National Wildlife Federation for $20. For more information and order forms contact: Noel Gerson, National Wildlife Federation, 1412 16th Street N.W., Washington D.C. 20036; (202) 637-3776.

Workshop on Modeling Methods in Biological Resource Management

N.S.F. is sponsoring a workshop on Modeling Methods in Conservation Biology at the University of Montana in Missoula on July 18 - August 12, 1988. The workshop is intended to bring together a group of 25 college teachers in the mathematical sciences, ecology, population biology, and biological resource management fields to participate in a 4-week summer program. The program includes lectures, computer modeling labs, and field trips, exploring scientific and socioeconomic issues in conservation biology. N.S.F. funding will cover participants' living expenses plus a $250 weekly stipend, during the 4-week session this summer and the 1-week follow-up in June 1989. Robert McKelvey, U.M. Professor of Mathematical Sciences and Editor of *Natural Resources Modeling* will be the workshop director. For further information and application forms, contact: Biological Resource Modeling Workshop, Wildlife Biology/Forestry, University of Montana, Missoula, MT 59812 (Phone 406-243-5272).

WWF Special Report on Biological Diversity

Last December, World Wildlife Fund published an end-of-year Special Report on Biological Diversity which estimates 1,000-10,000 species are becoming extinct each year due to various threats, such as tropical deforestation. The report contains articles on species conservation strategies, likely extinctions of birds, insects, and plants, and a list of threatened animal species which are dependent on tropical forests. In the Fall of 1988, WWF will launch a major campaign to raise funds and to stimulate political action for the conservation of biological diversity. The report may be obtained free by writing WWF International Information Division, 1196, Gland, Switzerland.

Bulletin Board information provided by Jane Villa-Lobos, Smithsonian Institution

Endangered Species UPDATE

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